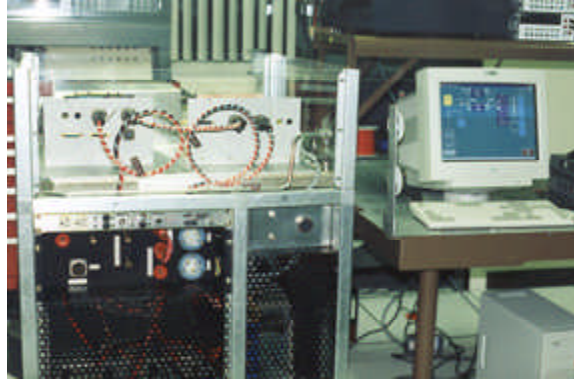


Power Management and Distribution System Developed for Thermionic Power Converters



Thermionic power management and distribution hardware.

A spacecraft solar, bimodal system combines propulsion and power generation into a single integrated system. An Integrated Solar Upper Stage (ISUS) provides orbital transfer capabilities, power generation for payloads, and onboard propulsion to the spacecraft. A key benefit of a bimodal system is a greater payload-to-spacecraft mass ratio resulting in lower launch vehicle requirements. Scaling down to smaller launch vehicles increases space access by reducing overall mission cost. NASA has joined efforts with the Air Force Phillips Laboratory to develop enabling technologies for such a system. The NASA/Air Force bimodal concept uses solar concentrators to focus energy into an integrated power plant. This power plant consists of a graphite core that stores thermal energy within a cavity. An array of thermionic converters encircles the graphite cavity and provides electrical energy conversion functions. During the power generation phase of the bimodal system, the thermionic converters are exposed to the heated cavity and convert the thermal energy to electricity. Near-term efforts of the ISUS bimodal program are focused on a ground demonstration of key technologies in order to proceed to a full space flight test. Thermionic power generation is one key technology of the bimodal concept.

Thermionic power converters impose unique operating requirements upon a power management and distribution (PMAD) system design. Single thermionic converters supply large currents at very low voltages. Operating voltages can vary over a range of up to 3 to 1 as a function of operating temperature. Most spacecraft loads require regulated 28-volts direct-current (Vdc) power. A combination of series-connected converters and power-processing boosters is required to deliver power to the spacecraft's payloads at this level.

The NASA Lewis Research Center developed the PMAD system for the ISUS bimodal thermionic converters. In-house development activities included design, analysis, fabrication, and tests of all major components. These include two series-connected boost regulators, a power distribution and control unit, and a data acquisition system. The series-connected boost regulators are based on the principle of adding a biasing isolated voltage

on top of the power source. Changes in the power source voltage are compensated for by adjusting the bias voltage.

This unique interconnect topology developed by Lewis has been demonstrated for various power system architectures. System efficiencies of up to 97 percent and power densities above 1000 watts per kilogram (W/kg) are just a few benefits of this technology. Of the additional hardware and software developed by NASA, the thermionic converter electronic simulator and thermionic performance evaluation system are noteworthy. Electrical characteristics of thermionic converters can be evaluated with this unique system. This capability enhances the NASA/Air Force team's ability to investigate the performance of spacecraft systems powered by thermionic converters. The PMAD system includes a graphical user interface for easy operation and can supply a maximum of 1500 W at 28 Vdc. Fabrication and test of the PMAD system was completed in August 1997.

Lewis contact: Anastacio N. Baez, (216) 433-5318, A.Baez@grc.nasa.gov

Author: Anastacio N. Baez

Headquarters program office: USAF

Programs/Projects: ISUS, ISS, HEDS